A Summary of the

Habitat Restoration Plan for the
Lower Tuolumne River Corridor

Prepared for: The Tuolumne River Technical Advisory Committee March 1999

The Tuolumne River

The Tuolumne River Technical Advisory Committee has prepared the "Habitat Restoration Plan for the Lower Tuolumne River Corridor" to assist them in identifying and implementing habitat restoration projects to benefit the river's chinook salmon. The complete Restoration Plan is lengthy and technical. This summary document provides background information about the TRTAC, the challenges facing the Tuolumne River corridor, some of the technical information used to create the restoration plan, and examples of restoration projects already underway. This summary was prepared to inform the public of the Restoration Plan goals and current and future restoration projects.

The Tuolumne River is one of the most important natural resources of California's Great Central Valley. The largest tributary of the San Joaquin River, the Tuolumne River drains a 1,900 square mile watershed that includes the northern half of Yosemite National Park. As the Tuolumne River emerges from the Sierra Nevada foothills into the Central Valley, it carries precious agricultural and municipal water supplies to a highly developed and diversified regional economy, Agriculture, ranching, mining, and tourism dominate the region and depend on the

An enormous biological community also depends on the Tuolumne River. Vast Fremont Cottonwood and Valley Oak riparian forests once insulated the Tuolumne River banks, extending several miles wide in the lower San Joaquin Valley, and merging into riparian forests of the neighboring Merced, Stanislaus and San Joaquin Rivers. These forests provided foraging and breeding habitat for an abundance of resident and migratory bird and wildlife populations, and tremendous populations of migratory waterfowl.

"On April 1" [1844] we...were stopped again by a river the Tuolumne....[I]ts beauty has been increased by the additional animation of animal life, and now it is crowded with bands of elk and wild horses; and along the rivers frequent fresh tracks of grizzly bears, which are unusually numerous in this country."

Captain John C. Fremont

In the lower foothill reaches of the Tuolumne River upstream of the communities of Waterford and La Grange, annual migrations of spring-run and fall-run chinook salmon once choked the river. Fish commonly weighed in excess of 60 pounds, occasionally reaching nearly 100 pounds! Despite recent declines, the Tuolumne River still supports the largest naturally produced population of chinook salmon remaining in the San Joaquin Valley.

MODESTO Creek

Mitchell Rd

Bridge

Santa Fe Ave Geer Rd

Bridge

Santa Fe Ave Bridge

HUGHSON

Luolumne history

1848 THE CALIFORNIA GOLD RUSH

No other event transformed the character of California as proceed to the country as the gold rush. Gold fever brought a roaring boom to the Tuojumne River and the entire Central Valley almost overnight. Stuicing, hydraulic mining, and later dredging left be hind a severely disfigured river acosystem. The legacy of dredging remains today as river rocks piled on: former river flood plains in the upper reaches of the Tuolumne River.

EARLY DIVERSION DAMS

river for their sustained livelihood.

The Tuolumne Water Company constructed Wheaton Dam at the falls above La Grange in 1871, initiating flow regulation and diversion on the Tuolumne River Wheaton Dam was later sold to Turlock and Modesto Irrigation Districts; then replaced by La Grange Dam. Completed on December 13, 1893 at a cost of \$550,000, the 127 ½ ft high La Grange dam (later raised 2 ¼ ft) was the highest overflow dam in the country.

1923-1928 EARLY STORAGE DAMS

The completion of O'Shaughnessy Dam in 1923 (Hetch Hetchy) initiated water storage and diversion from the Tuolumne River to supply drinking water to San Francisco. Don Pedro Dam, formally dedicated on June 25, 1923, was constructed in little more than 2 years, and was again the highest dam of its kind (284 ft high). The additional 289,000 acrefect of water storage extended the irrigation season through September in most years.

1900'S TO PRESENT AGRICULTURAL/URBAN EXPANSION

Agricultural and urban expansion have encroached on the Tuolumne River's space, and have eliminated large areas of fish and wildlife riparian habitats. Entire floodplains were converted for cultivation, bridges and towns were constructed, and levees erected to protect urban infrastructures from floods. Economics developed during the 20th century are now inextricably linked to Tuolumne River resources.

${\mathcal A}$ candidate for restoration

Today, however, the Tuolumne River is changed. More than a century of intensive land and water resource development has transformed the Tuolumne River. Native Americans managed the watershed using fire and selective vegetation harvesting. Gold dredging and hydraulic mining began during the Gold Rush and continued into the 1950s. Mining sand and gravel "aggregate" for road and construction material began in the 1940s with miners excavating directly from the river channel. Present day mining activities occur in adjacent floodplains and terraces.

THE LEGACY OF DEVELOPMENT:

- · reduced quantity and quality of salmon habitat
- · impaired chinook salmon population
- · reduced floodway capacity
- reduced frequency of large floods and reduced variability of seasonal streamflows
- lost gravel supply
- fragmented and narrowed riparian corridor and decreased plant species diversity
- · decreased regeneration of native riparian plants
- diminished wildlife populations
- reduced water quality

Agriculture and urban development have also severely confined the river's space. The river is formed and maintained by water and sediment, but dams now divert more than half the Tuolumne River's streamflow and block the river's coarse sediment and organic nutrient supplies. Cumulatively these changes have altered the river ecosystem. The ability of the river to maintain its health has been greatly impaired. The river needs active restoration to improve.

WATERFORD
Hickman
Bridge
HICKMAN



Gold dredgers excavated gravel from deep under the river and floodplains, separated out the gold, and deposited the tailing across the valley. Within a few decades (1937 above, 1950 left) the dredgers turned over most of the valley floor from La Grange to Roberts Ferry.

New LA GRANGE La Grange DAM Bridge LA GRANGE

1930'S TO PRESENT GRAVEL MINING

Sand and gravel "aggregate" is a critical resource to a rapidly developing region. Early mining practices created large pits within the river channel that now harbor non-native fish and block gravel movement downstream. As aggregate demand increased, mining shifted to floodplains and terraces and created large pits that now constrict the river between berms that are frequently ruptured during floods.

1971 NEW DON PEDRO PROJECT

The New Don Pedro Project (NDPP), provides irrigation water and hydro-power for Turlock and Modesto Trrigation Districts, municipal water supplies for the City and County of San Francisco, and flood control for the U.S. Army Corp of Engineers: The 545 ft high rock-filled damwas dedicated on May 22, 1971. Initial streamflows were low, and the project license required re-evaluating stream-flows after twenty years of operation.

1971-1995 REGULATION UNDER NDPP OPERATION

ROBERTS

Roberts

Ferry Bridge

FERRY

Fall-run salmon population fluctuated widely during the first 20 years of NDPP operation, from a high of 45,000 fish (1985) to lows of 100 fish (1991-93). Article 37 of the NDPP license mandated extensive studies of salmon ecology to determine how much water was needed to maintain a healthy population. This knowledge now confributes to understanding how environmental factors affect the chinook salmon population.

1995 FERC SETTLEMENT AGREEMENT

The NDPP license was re-opened in 1992 to evaluate streamflow requirements. The FERC Settlement Agreement increased streamflows to aid chinook salmon recovery, and formed the Tuolumne River Technical Advisory Committee to oversee restoration and management. The TRTAC has prepared the Habitat Restoration Plan for the Lower Tuolumne River Corridor to guide restoration planning funding and implementation.

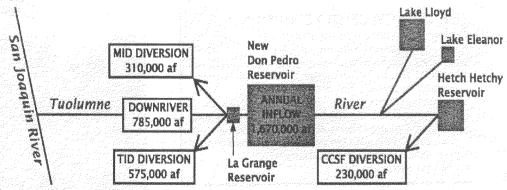
A managed river

The Tuolumne River has a long history of streamflow regulation and diversion. The Turlock and Modesto Irrigation Districts (TID/MID) have operated storage and diversion facilities on the Tuolumne River for over a century. La Grange Dam, constructed in 1893, was the first TID/MID joint facility and continues to serve as the diversion point for the TID and MID main canals. Increased demands for water resulted in construction of Don Pedro Dam in 1923, which was replaced by the New Don Pedro Project (NDPP) in 1971. The NDPP reservoir, with a capacity of 2 million acre-feet (af), is the largest storage facility on the Tuolumne River. The City and

County of San Francisco (CCSF) divert additional water from Hetch Hetchy Reservoir and other upper Tuolumne River projects. Cumulatively, these projects divert more than half the average annual flow from the Tuolumne River.

The Federal Power Commission [now the Federal Energy Regulatory Commission (FERC)], issued the original NDPP license in 1964, which required TID/MID to release minimum streamflows to

protect the native chinook salmon population. The NDPP license also required the Districts, in cooperation with Federal and State resource agencies, to study the Tuolumne River to "assure continuation and maintenance of the salmon fishery in the most economical and feasible manner". Studies were carried out cooperatively by the Districts, U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Game (CDFG). These studies, summarized in reports submitted to FERC in 1992, described chinook salmon ecology and provided management recommendations based on current scientific understanding of the Tuolumne River.



Over half of the 1.9 million acre-feet (af) of runoff in the Tuolumne River basin is diverted from the river each year for agricultural and municipal use.

The FERC Settlement Agreement

The NDPP license required FERC to re-evaluate the project's minimum streamflow requirements after 20 years of operation. FERC initiated this evaluation in 1992, and prepared a Final Environmental Impact Statement (FEIS) in compliance with the National Environment Policy Act (NEPA). The first ever FERCinitiated mediation process resulted in adoption of the 1995 FERC Settlement Agreement (FSA). The FERC Settlement Agreement participants included TID/MID. the City and County of San Francisco and other water suppliers, state and federal resource agencies, and several environmental groups. The Agreement revised streamflow requirements, required habitat restoration to improve conditions for chinook salmon, and ordered additional fishery studies to evaluate flow and non-flow measures.

FERC SETTLEMENT AGREEMENT PARTICIPANTS

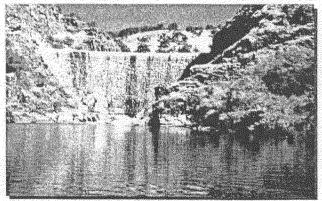
California Department of Fish and Game (CDFG)
California Sports Fishing Protection Alliance (CSPA)
City and County of San Francisco (CCSF)
Federal Energy Regulatory Commission (FERC)
Friends of the Tuolumne (FOTT)

Modesto Irrigation District (MID)
San Francisco Bay Area Water Users Association (BAWUA)
Tuolumne River Expeditions (TRE)

Tuolumne River Preservation Trust (TRPT)

Turlock Irrigation District (TID)

U.S. Fish and Wildlife Service (FWS)



La Grange Dam, at river mile 52.2, is the upstream extent of the Restoration Plan.

The Tuolumne River Technical Advisory Committee

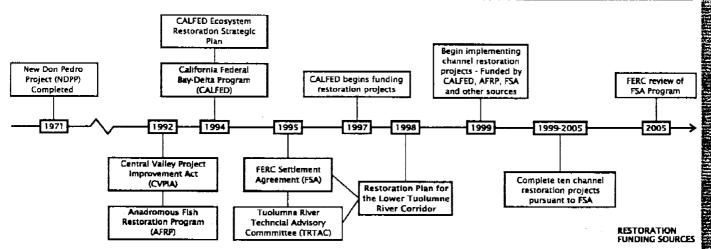
The Tuolumne River Technical Advisory Committee (TRTAC) was formed to coordinate and administer restoration and management activities on the Tuolumne River. The TRTAC participants include the FERC Settlement Agreement signatories and other interested groups.

The TRTAC was directed to identify and implement ten high priority habitat restoration projects by 2005, at which time progress toward restoring the salmon population will be re-evaluated. To aid in identifying and implementing high priority restoration projects, the TRTAC developed the *Habitat Restoration Plan* for the Lower Tuolumne River (Restoration Plan).

The Restoration Plan is intended as a technical resource to help the TRTAC fulfill its obligation under the FERC Settlement Agreement.

FERC SETTLEMENT AGREEMENT GOALS AND STRATEGIES FOR RECOVERY OF TUOLUMNE RIVER CHINOOK SALMON

- · Increase naturally occurring salmon populations
- Protect any remaining genetic distinction of Tuolumne River salmon
- Increase salmon habitat in the Tuolumne River
- Implement measures generally agreed upon as necessary to improve chinook salmon habitat and increase salmon populations. These measures include increased flows, habitat rehabilitation and improvement, and measures to improve juvenilesurvival
- Use an adaptive management strategy that would initially employ measures considered feasible and have a high chance of success
- Conduct a detailed annual review to assess progress toward meeting the goals described in the Settlement Agreement



Implementing the New Don Pedro Project FERC Settlement Agreement is a combined effort by multiple restoration programs and groups,

Habitat Restoration Plan for the Lower Tuolumne River Corridor

This document is a summary of the larger technical report, and was developed to assist the TRTAC in presenting the Restoration Plan to the Public.

"Restoration" often implies returning to historical or natural environmental conditions. Because removing dams, eliminating water diversion, and ceasing agricultural and mining activities within the river coridor are unrealistic goals, restoring the river to pristine conditions is impossible.

VISION FOR RESTORING THE LOWER TUOLUMNE RIVER CORRIDOR

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Utilize an integrative approach to re-establish critical ecological functions, processes, and characteristics, under regulated flow and sediment conditions, that best promotes recovery and maintenance of a resilient, naturally producing salmon population and the river's natural animal and plant communities.

RESTORATION PLAN OBJECTIVES

- Investigate and describe current and historical riverconditions
- Integrate geomorphic, riparian and fisheries investigations into recommendations and strategies for restoring the Lower Tuolumne River corridor
- Develop proposals and designs for specific restoration actions.

Therefore, the Restoration Plan was intended to recommend ways to significantly *improve* conditions within the Tuolumne River corridor, while recognizing that land and water-use activities will continue. The restoration approach recommended for the Tuolumne River is to improve conditions for chinook salmon and other species by *restoring self-sustaining ecological processes*. This approach benefits not only the target species, chinook salmon, but also many other plants and animals dependent on the health and integrity of the Tuolumne River.

Juolumne River hydrology

Water and sediment are critical ingredients for forming and maintaining the river channel, creating habitat, and supporting the biological communities that depend on flowing water. The Tuolumne River's natural flow regime varied day-to-day, seasonally, and year-to-year depending on rainfall and snowmelt. Scientists now recognize that the dynamic character of streamflow plays a fundamental role in maintaining the health of river ecosystems.

DOWNSTREAM OF THE DAMS

- Total volume of water flowing down the river is decreased
- Magnitude and duration of floods are reduced
- Magnitude of summer baseflows are reduced
- Spring snowmelt runoff is reduced

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Timing and frequency of natural floods is altered

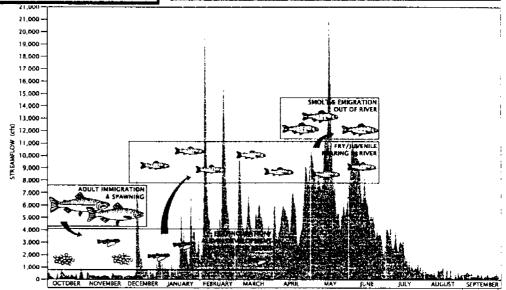
mine precisely how the magnitude, timing, frequency and duration of natural streamflow patterns have been altered, and to suggest ways to improve the management of flow releases without reducing water supplies.

THE NATURAL FLOW REGIME

- · Maintains natural channel form
- Cleanses spawning gravels of silts and deposits silts on floodplain surfaces
- Inundates floodplains during native riparian plant seed dispersal and germination
- Occassionally disturbs mature riparian vegetation to maintain diversity
- · Stimulates chinook salmon immigration and emigration
- Maintains spawning habitat

Water regulation for irrigation, power generation, and drinking water has altered the natural flow patterns of the Tuolumne over the past 100 years. These impacts have accelerated over the century as more substantial water storage and flood flow modification have occurred with each new and larger dam built.

The Restoration Plan analyzed daily streamflow records for the entire 101 years of flow records (WY 1897-1998), analyzing the seasonal and annual variation and comparing regulated with unregulated conditions. Combined with a flood-frequency analysis, this information was used to deter-



Streamflow for a given water year (October 1 to September 31) can be shown as an annual hydrograph of the daily average flows in cubic-feet per second (cfs). The life cycle of chinook sulmon (and other riverine species) have adapted to the seasonal variability of natural streamflow patterns.

flood flow evaluation...

Floods are natural events within river corridors, and are critical to a healthy river ecosystem. While the Restoration Plan did not address long-term flood management, the January 1997 flood did provide a unique opportunity to reevaluate the role of floods on the Tuolumne River.

The 60,000 cfs discharge that occurred on January 3, 1997 historically occurred about every 35-50 years, and the "100-year flood" probably exceeds 85,000 cfs. While uncontrolled floods of these magnitudes threaten lives and property and should be avoided, controlled floods of lower magnitude are essential for the river's recovery and long-term health, and should be allowed. Expanding the floodway provides a "winwin" solution. A larger flood corridor gives dam operators greater flood release flexibility when faced with large inflows into Don Pedro reservoir. This will reduce the risk of future catastrophic floods like the '97 flood. An expanded floodway will also allow operators to occasionally release managed floods that are necessary for channel maintenance.

Managed floods can restore several river and riparian processes, including streamflow patterns with greater variability,

FLOODWAY ASSESSMENT

The Army Corps of Engineers (ACOE) completed a "Reconnaissance Study" of the Tuolumne River floodway in October 1998, which identified potential alternatives for managing future floods, and encouraged continued environmental restoration within the Tuolumne River corridor. The ACOE will now proceed with a "Feasibility Study" to identify a preferred alternative to reduce the risk of future catastrophic flooding and improve flood management. The ACOE and DWR are also conducting the "Sacramento and San Joaquin River Basins Comprehensive Study" to assess flood management on a broader scale.

frequent cleansing and transport of river gravels to maintain spawning gravel quality, a river channel that migrates within its floodplain, and floodplains that are inundated at moderateto-high streamflows to help stimulate plant regeneration. Additionally, managed floods need not exceed the floodway capacity (i.e., no flooding that threaten man-made structures), nor streamflow quantities specified in the FERC Settlement Agreement (i.e., no net loss water supply availability).

hinook salmon life history

Chinook salmon exhibit *anadromy*, a river-to-ocean, ocean-to-river life cycle. Young salmon migrate to sea shortly after emerging from spawning gravels, and spend most of their life in coastal waters where they grow large from abundant food supplies. Fall run chinook adults return to spawning grounds in the fall and early winter. The female digs a pit in river gravels and deposits her eggs as the male fertilizes them. Both soon die shortly after spawning, spending their final days guarding the nest. Juveniles emerge from spawning gravels between December and April and "rear" in deep, slow portions along river margins, either upstream near the spawning beds



Fall-run chinook salmon constitute over 90% of the salmon in the Central Valley, and support the bulk of commercial and recreational salmon harvest.

or downstream in the Sacramento-San Joaquin Delta. Historically, high spring flows during the snowmelt runoff helped juveniles migrate out to sea before high summer temperatures made river conditions less hospitable.

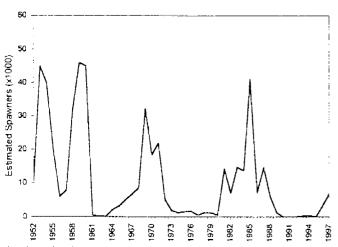
Chinook salmon are superbly adapted to natural river conditions such as annual streamflow patterns of floods and low-flow periods, cold water temperatures, the natural river morphology (deep pools and shallow riffles), as well as the native fish community. Human activities that detrimentally impact natural river conditions also diminish survival and reproductive success of salmon. Declining populations become unstable and may become extinct if conditions are not substantially improved.

FACTORS AFFECTING SALMON PRODUCTION AND SURVIVAL

- Spawning gravel supply and gravel quality
- Juvenile rearing habitat availability and condition
- Streamflow during fry, juvenile, and adult migration periods
- Predation by non-native fish species (bass)
- Bay/Delta and ocean mortality (predation, delta pumping, sport/commercial harvest)
- · Water temperatures and water quality...

urrent status of chinook salmon --

Despite the efforts of fisheries managers, many chinook salmon populations have continued to decline. The spring-run chinook salmon, historically the most abundant salmon run in the San Joaquin River basin, was extinct by the early 1950s, as



The chinook salmon population has fluctuate widely over the years, in response to environmental conditions the fish experience as juveniles, delta water exports, ocean conditions, and commercial and recreational harvest.

early dams blocked fish from reaching their high elevation spawning grounds. In the decades following, the fate of the remaining fall-run chinook population has hung precariously in the balance. Periods of abundant adult returns were punctuated by years of dangerously low returns of 500 fish or less (1962, '63, '77, '91, '92, '93). The return of 8,000 spawners to the Tuolumne River in 1998 has restored confidence that a population of wild salmon can be rebuilt from low numbers.

As of October 1997, five Pacific Coast salmon runs were listed as endangered under the Federal Endangered Species Act. Currently, the National Marine Fisheries Service is reviewing all 19 Pacific Coast chinook salmon stocks, including the San Joaquin River basin (includes Tuolumne River) fall-run chinook salmon, to determine if further listings are warranted.

The Restoration Plan offers a long-term solution to restoring and protecting the chinook salmon population by incorporating the physical processes that create and maintain good habitat conditions. Additionally, restoration will benefit other riverine species and the vegetation community that provides habitat for birds and other wildlife populations.

atural channel processes...

The foundation of a river ecosystem is the dynamic interaction and a review of scientific literature, the "Attributes of River

of one of these factors disrupts the balance of the other factors. For example, clearing riparian vegetation may increase bank erosion and channel meandering. Dams block the downstream movement of gravel from the upper watershed, causing gravel bars downstream of dams to be scoured away without being replaced. And absence of

floods allows fine sediments to accumulate in gravels, inhibiting the survival of chinook salmon eggs. These impacts in turn degrade or eliminate important fish and wildlife habitat and reduce their populations.

Based on an historical evaluation of Tuolumne River hydrology (streamflow patterns) and geomorphology (river channel form).

of flowing water, sediment, and riparian vegetation. Alteration

Ecosystem Integrity" were developed to describe how the Tuol-

umne River functioned historically, and also to serve as measurable restoration objectives. By managing streamflows, reducing unwanted fine sediment supply, increasing important coarse sediment supply, and restoring a natural channel form, many of the critical river attributes and processes can be acheived.

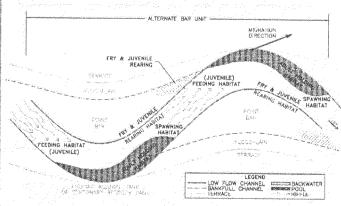
This restoration approach focuses on restoring a natural pattern of periodic disturbance and continual re-growth that creates a mosaic of high quality habitat for many species, including salmon. Without these dynamic processes, the river has become static and less productive.

ttributes of river ecosystem integrity

ATTRIBUTE #1

Spatially complex channel shape (morphology)

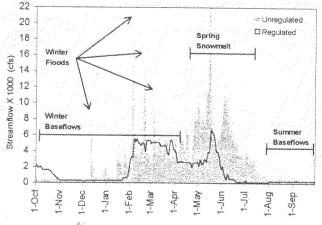
No single segment of river provides habitat for all species, but the sum of diverse areas provides high-quality habitat for native species.



ATTRIBUTE #2

Variable streamflow patterns

Seasonal streamflow patterns are broadly predictable, but specific flow magnitudes, timing, durations, and frequencies are unpredictable due to runoff patterns produced by storms. droughts and snowmelt. Streamflow variability is a foundation of river ecosystem health.



ATTRIBUTE #3

Luna Leopold

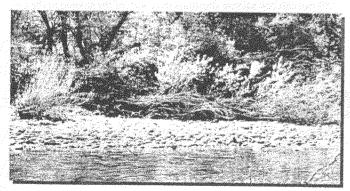
"The channel is carved by the flowing

water, but it takes the form dictated

by the sediment carried.

Frequently disturbed channelbed surface

In the upper river where the river bed is mostly made of gravel, surface gravels and cobbles are moved downstream by moderate-sized floods which occur on average every 1 or 2 years. In the lower river where the bed is mostly sand, sand is moved downstream during much of the year, creating migrating "dunes" and shifting sand bars.



ATTRIBUTE #4

Periodic riverbed scour and fill

In gravel-bedded reaches, gravel bars are cleansed deeper than their surface layers by larger floods which occur on average every 3 to 5 years. This "scour" is typically accompanied by "fill" from upstream gravel sources, to maintain a balance in natural channel form.

ATTRIBUTE #5

Balanced fine and coarse sediment volumes

The location and volumes of sediment within a river reach may vary year to year, but over the long term sediment imports and exports are balanced, and the channel form remains similar. A balanced sediment load implies that streamflows are periodically high enough to move most sediment sizes (sand and boulders) of the river.

...the technical aspects of river ecosystems

An example of the dynamics of natural rivers: (A) a channel with adequate space to migrate (Attribute 6) erodes the channel bank on the outside of the meander bend during high flows (Attribute 2), (B) encouraging aged riparian trees to topple into the channel (Attribute 9). (C) A deep pool also forms here, which provides structural complexity (Attribute 1) for good fish habitat. As bank erosion continues, the pool "migrates" downstream (Attribute 6), but high quality habitat is maintained. (D) On the opposite bank, high flows

(Attribute 2) scour and redeposit coarse sediments (Attributes 4 and 5), forming a shallow bar on the inside of the meander bend (Attribute 1), and providing clean spawning gravels. (E) This area, in turn, provides ideal slow-water rearing conditions for juvenile chinook salmon, as well as habitat for aquatic

Initiating riperion regetation

Sediment input

Fraction

Sediment input

Channel description

Channel description

Channel description

insects (fish food), amphibians and reptiles. (F) Progressively higher up the gravel bar surface, a dynamic interplay occurs between

receding water levels during the spring snowmelt (Attribute 2), and the presence of riparian tree seeds (Attribute 7). These woody riparian trees are sporadically scoured out (Attribute 8), and those established high enough on the bank are toppled into the channel as the channel migrates back across the valley (A).

ATTRIBUTE #6

Periodic channel migration and/or avulsion

The channel erodes riverbanks, deposits new gravel bars, and establishes meander patterns based on variable streamflows, valley slope, river channel confinement, sediment supply, and sediment size. In the gravel-bedded reaches, the channel moves from one location to another by "avulsion" or sudden change, leaving much of the abandoned channel intact. In the sand-bedded reaches, meanders gradually erode through banks and cut off meander bends, leaving oxbows.

ATTRIBUTE #7

A functional floodplain

Every one or two years, on average, high streamflows inundate the lowermost floodplains, deposit silts and sand, and stimule germination of riparian vegetation. Lower terraces, at a slightly higher elevation than floodplains, are inundated by less frequent floods.



ATTRIBUTE #8

Infrequent channel resetting floods

Single large floods (recurring once every 10 to 20 years) cause major channel changes that rejuvenate riparian processes, form and maintain side channels, and create off-channel wetlands, such as oxbows.



ATTRIBUTE #9

Self-sustaining, diverse riparian corridor

Based on species life history strategies and streamflow patterns, the riparian plant community is maintained by a continual cycle of germination, growth, and death. The riparian community thus contains young and old vegetation, and a diversity of species.



ATTRIBUTE #10

Naturally fluctuating groundwater table

Groundwater fluctuates on a seasonal and annual basis in floodplains, terraces, and sloughs.

uolumne River restoration strategies

Rivers are resilient ecosystems with enormous capacity for self-rejuvination. However, given that land-use practices and water regulation and diversion will continue, the river cannot recover in a reasonable timeframe without help. The Restoration Plan recommends several strategies to initiate recovery, such as filling mining pits, introducing spawning gravels, lowering selected floodplains to allow inundation, and replanting native riparian vegetation. Equally important, flood and gravel management will help re-establish processes to maintain restored areas and improve other areas as well.

The Restoration Plan recommends general restoration strategies for different reaches along the river, as well as specific restoration projects within those reaches. Inherent with any restoration plan of this scale is some degree of uncertainty regarding the effectiveness of specific restora-

tion actions. Therefore, an adaptive management program would require 1) monitoring restoration sites, 2) evaluating restoration success against desired conditions, and 3) improving restoration strategies. This will ensure progress toward recovery goals.

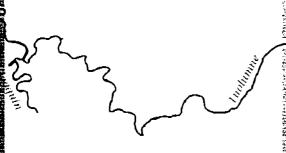
Implementation of any restoration project will be subject to prior environment review by local, state, and federal regulatory agencies. The TRTAC participants recognize that decisions affecting the Tuolumne River are influenced by diverse policies relating to land use, water supply and use, water quality, flood control, fish and wildlife, and recreation, and are not governed solely by habitat considerations. Additionally, the TRTAC recognizes the importance of cooperation and participation from landowners, the local business community, and the general public.

ong-term restoration recommendations

- SAND-BEDDED ZONE (RM 0.0 TO RM 24.0) -

Restore floodway capacity to 15,000 cfs or greater above Dry Creek and 20,000 cfs or greater below Dry Creek Reduce urban and agricultural encroachment to create/maintain a 500-2,000 ft or greater floodway width Remove rip-rap and berms where feasible to restore floodplains and to allow migration within the floodway Seek conservation easements and/or land acquisitions (especially of flood-prone lands) from willing landowners Remove exotic plants within riparian corridor and replant native species Secure protection for existing mature valley oaks and Fremont cottonwoods

Improve water quality by managing urban, agricultural and industrial runoff into the river and into Dry Creek



REACH 1 (RM 0.0-10.5)

Lower Sand-bedded Reach

- · Restore off-channel wetlands to increase wildlife habitat
- Create riparian buffer to filter agricultural runoff
- Restore functional floodplains and native riparian forests
- Evaluate cover crop strategies to improve soil conservation



REACH 2 (RM=10.5-19.3)

Urban Sand-bedded Reach

- Improve Tuolumne River Re giorral Park by increasing area of native riparian trees
- Create and preserve riparian buffer along urban/industrial zones
- Remove trash and debris. eliminate chronic sources of pollution, and actively monitor illegal dumping
- Increase public awareness of the Tuolumne and promote cleanup, restoration and monitoring

REACH 3

(RM 19.3-24.0)

EMPIRE

Upper Sand-bedded Reach

- Preserve existing urban setback from
- Create and preserve a riparian buffer along urban/agricultural zones

HUGHSON

REACH 4

In-Channel G : Isolate/fill i

- predation o bedload trai
- Restore a na Create and I
- along urban

RIVER-WIDE RESTORATION GOALS

- · Chinook salmon habitat maintained by natural processes, sustaining a viable, naturally reproducing chinook salmon population.
- Adequate quantity of high quality gravel, maintained by periodically replacing gravels transported downstream by high flows
- A dynamic river channel, maintained by floods of variable magnitude and frequency that periodically initiate critical channel processes
- A continuous river floodway and riparian corridor from La Grange Dam to the confluence with the San Joaquin River
- · Increased extent of naturally regenerating native riparian stands and decreased extent of exotic plants
- · Adaptive management program that continually reviews and refines restoration and management activities, and addresses areas of scientific uncertainty that will improve our understanding of river ecosystem processes.
- Improved water quality through urban and agricultural runoff management programs
- * Public awareness and involvement in the Tuolumne River restoration effort

GRAVEL-BEDDED ZONE (RM 24.0-52.1) --

Increase gravel supply throughout the zone and increase the frequency of gravel movement Reduce fine sediment supply and storage

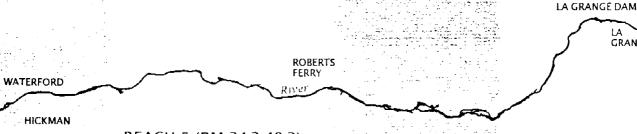
Restore floodway capacity to 15,000 cfs or greater

Reduce agricultural and mining encroachment to create/maintain a 500 ft or greater coridor width Remove rip-rap and berms where feasible to restore floodplains and to allow migration within the floodway Manage flood control releases to initiate bed movement and other dynamic channel processes

Restore a continuous corridor of native riparian vegetation

Improve habitat quality of off-channel wetlands

Seek conservation easements and/or land acquisitions (especially of flood-prone lands) from willing landowners Remove exotic plants within riparian corridor and replant native species Introduce alternative grazing strategies to promote riparian regeneration



(R4.0-34.2)

avel Minina Reach stream mining pits to reduce bass juvenile salmon and reestablish sport continuity ural river and floodplain aintain riparian buffer (corridor) agricultural zones

REACH 5 (RM 34.2-40.3)

Gravel Minina Reach

- Isolate off-channel mining pits to prevent river connection during floods up to 15,000 cts to reduce salmonid stranding and bass predation on juvenile salmon
- Increase floodway width to at least 500ft
- Restore a natural river and floodplain morphology
- Restore and maintain riparian corridor through gravel mining zones

REACH 6 (RM 40.3-46.6)

Dredger Tailing Reach

- Reconstruct remnant. channel left by gold dredger operations to a natural river and floodplain
- Restore riffles to increase salmon spawning and rearing habitat
- Regrade floodplains to reduce salmonid stranding and promote riparian regeneration ***
- Reduce riparian encroach ment onto low flow channel
- Reduce grazing impacts to promote riparian regeneration
- Secure remnant dredger tailings for future restoration

REACH 7 (RM 46.6-52.1)

Critical Spawning Reach

- Reduce sand input into river and remove sand stored in riverbed
- Increase and maintain spawning gravel supply
- Restore riffles to increase salmonid spawning and rearing habitat
- Regrade floodplains to reduce salmonid stranding and promote riparian regeneration
- Reduce riparian encroachment onto active channel
- Reduce grazing impacts to promote riparian regeneration on floodplains

Restoration in progress .

Responding to the FERC Settlement Agreement mandate to implement ten high-priority restoration projects by 2005, the TRTAC has received funding for several projects from the CALFED Ecosystem Restoration Program and the US Fish and Wildlife Service's Anadromous Fish Restoration Program (AFRP). The TRTAC has selected six projects which are now in the planning and design phase. The remaining four projects are currently being evaluated.

Other entities are also proposing or conducting restoration activities on the Tuolumne River, including the US Army Corp of Engineers, US Fish and Wildlife Service, California Department of Fish and Game, Natural Resource Conservation Service, East Stanislaus Resource Conservation District, Friends of the Tuolumne, California State Parks, and the Joint Powers Authority (City of Modesto, City of Ceres, and Stanislaus County). Several of these projects are illustrated below.

SAN JOAQUIN RIVER NATIONAL WILDLIFE REFUGE

US Fish and Wildlife Service

This site represents one of the few remaining floodplains in the San Joaquin basin that has much of its riparian habitat intact. Since this habitat is critical for resident and migrant bird overwintering, breeding, foraging, and migration stopover, preserving this site is essential. USFWS is purchasing these frequently flooded lands to protect riparian woodlands, revegetate cleared lands, and manage for wildlife.

TUOLUMNE RIVER REGIONAL PARKWAY

Joint Powers Authority (City of Modesto, City of Ceres, Stanislaus County)

This project has been undertaken by the Cities of Modesto and Ceres, and Stanislaus County since 1967 with the vision of creating a continuous river parkway through greater Modesto. Since 1968, approximately 700 acres of riverside property have been acquired to create the Parkway. The Joint Powers Authority is now revising the land use plan for the Parkway, preparing a Master Plan for the Gateway Parcel at the Dry Creek confluence, and will soon be implementing a variety of restoration activities within the parkway.

MODESTO Dry Creek

CERES

MODESTO Dry Creek

HUGHSON

GRAYSON RIVER RANCH CONSERVATION EASEMENT

Natural Resource Conservation Service
East Stanislaus Resource Conservation District
USFWS/AFRP

The Grayson River Ranch site, located 5 miles from the confluence with the San Joaquin River, is subject to frequent flooding. A partnership of private, local, state and federal agencies and groups are funding a Perpetual Conservation

Easement for this land. The Grayson project has the potential to become a model for future conservation of floodplain and riparian habitats on the Lower Tuolumne River. (See next page for a more detailed description.)

SPECIAL RUN POOLS 9 AND 10 CHANNEL RESTORATION

Tuolumne River Technical Advisory Committee

SRPs 9 and 10 are large in-channel gravel mining pits located in a mile-long reach downstream of Fox Grove County Park. These pits harbor populations of non-native bass that are known to prey on young salmon. Restoration will eliminate bass habitat and increase riparian vegetation. These projects have received funding from CALFED and USFWS/AFRP, and are scheduled to begin in 1999 (see next page for more detailed description).

${\cal R}$ estoration Types

Preservation sites: Preserve sites containing the remaining riparian forests.

Floodway expansion: Provide a wider floodway and restore floodplains to reduce river confinement, allow natural channel migration, provide additional flexibility for dam operations to reduce the risk of catastrophic floods, increase riparian vegetation, and improve river habitat conditions.

Riparian restoration: Replant riparian vegetation to help promote natural regeneration, specifically targeting Fremont cottonwood and valley oak species.

Channel reconstruction: Rebuild a natural channel shape that allows gravel movement, channel migration, floodplain inundation, riparian regeneration, and sand/silt deposition on floodplains.

Conservation easements: Preserve riparian areas (especially flood-prone lands) to be held in the public trust, while ownership of the land is maintained by private individuals. Riparian restoration could be implemented within the conservation easement.

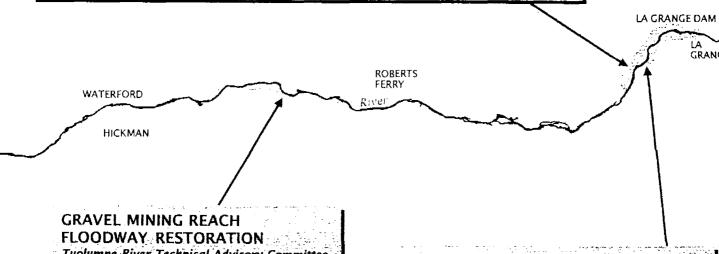
Sand management (fine sediment): Reduce fine sediment within riverbed gravels, by prevention, mechanical means and/or periodic managed flood releases.

Gravel management (coarse sediment): Provide an initial large volume of gravel to replace the gravels lost over the past century, then periodically introduce gravel to balance the loss of gravels moved downstream during high streamflows. Additional management approaches: Increase water quality by controlling urban and agricultural runoff, introduce alternative grazing strategies within floodway to promote native riparian regeneration, introduce covercrop strategies to decrease erosion of agricultural lands and non-point source pollution into river.

BASSO ECOLOGICAL RESERVE LAND PURCHASE

California Department of Fish & Game, Stanislaus County

Acquisition of three parcels totaling 42 acres is being funded by CALFED. This land between La Grange Bridge and Basso Bridge represents the "missing link" connecting adjacent 350-acre (west) and 185-acre (east) county-owned parcels. This reach is one of the primary chinook salmon spawning areas, and the land purchase will preserve the spawning habitat from future degradation.



Tuolumne River Technical Advisory Committee
This 7-mile reach near Waterford (from Roberts
Ferry Bridge to the Old Reed Rock Plant) supports
active off-channel gravel mining, and was extensively damaged during the 1997 flood. CALFED
and USFWS/AFRP have funded the first of four
phases of this project, with Phase I set to begin in
1999 at the upstream-most reach. Phases II-IV will
proceed in subsequent years. Restoration activities will include increasing floodway capacity to
convey at least 15,000 cfs, increasing salmon
spawning and rearing habitat, protecting dikes
and off-channel pits from future flood damage,
and restoring riparian forests on floodplains.

SPAWNING GRAVEL SUPPLEMENTATION

California Department of Fish & Game

Construction of La Grange Dam in 1893 permanently ended gravel supply to downstream reaches of the Tuolumne River. Restoring gravel supply to the Tuolumne River below La Grange Dam will greatly improve salmon spawning and rearing habitats. The project starts with initial mechanical placement of a large volume of gravel to begin replacing over 100 years of lost gravel supply, followed by periodic augmentation to maintain supply as gravels slowly move downstream.

Special Run Pool 9 and 10: A channel reconstruction project

An excellent way to understand the scope of river restoration on the Tuolumne River is to witness a project in progress. The opportunity will soon be afforded by the Special Run Pool 9 (SRP 9) Restoration Project. Visible looking west from the Geer Road Bridge, SRP 9 is located immediately downstream of Fox Grove County Park. The Technical Advisory Committee selected SRP 9 as one of the Settlement Agreement projects, and received approximately \$2.5 million in funding from CALFED and USFWS/AFRP. At present, environmental permitting and compliance documents are nearing completion, engineers are preparing final design details, and construction is scheduled to begin in summer of 1999. The Turlock Irrigation District is administering the project for the TRTAC.

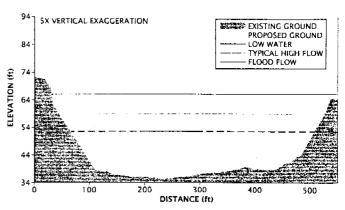


Instream and off-channel gravel mining began in this reach in the 1950s. Today, 30-foot deep pits provide habitat for bass (a predator of juvenile salmon) and also block sediment movement through this reach.

WHAT TO DO

Section 12C of the Settlement Agreement specified "at least two pond isolation projects will be included in the 10 priority projects." The TRTAC considered a variety of alternatives for restoring SRP 9, such as constructing a dike to separate the channel from the large backwater pit, or actively removing unwanted predator fish, leaving the pond as is. In the end, the TRTAC determined that the best solution was to re-fill the entire pit with gravel and cobble to reconstruct a natural river channel, restore a natural channel and floodplain form, and re-vegetate floodplains with cottonwoods, valley oaks and other native vegetation. This approach will help restore natural river processes, will provide additional riparian habitat, and will improve conditions for chinook salmon by creating new juvenile habitat and eliminating predator habitat. By targeting multiple objectives and trying to restore "ecosystem processes" in addition to improving conditions for a single species, the SRP 9 project is essentially a large-scale experiment, and will be thoroughly monitored over the next several years to determine if project objectives are met.

When complete, the restored project reach will provide a permanent solution to decades-old problems, and represent a significant piece of the 52-mile Tuolumne River corridor restoration effort.



As shown in a typical cross section through the SRPs, the existing channel is four times wider and at least two times deeper than it should be. Narrowing the channel will eliminate bass habitat, allow gravels to move through the reach, and will provide floodplains for replanting riparian vegetation.

A BRIEF HISTORY

Beginning in the 1930s, gravel miners extracted valuable sand and gravel aggregate directly from the river channel, creating large pits in the river with water depths up to 36 ft. Excavating these ponds eliminated salmon spawning and rearing habitat, as well as entire floodplains and riparian vegetation. These large pits now trap all coarse sediment (gravel and cobble) carried downstream by high flows, and provide warm-water habitat for non-native bass species that eat chinook salmon smolts as they migrate out to sea. Studies found largemouth bass densities to be as high as 750 adult bass per river-mile. Since every chinook salmon juvenile produced on the Tuolumne River must pass through this reach, bass have the potential to consume many thousands of juvenile salmon during the outmigration season. Reducing bass predation by eliminating their habitat is thus a high priority objective for restoring the chinook salmon population.



Prior to aggregate extraction, the Tuolumne River had a natural channel and floodplain form. Riparian vegetation was scattered across the floodway and gravel bars were exposed at low flows.

grayson River Ranch: A perpetual conservation easement

The Grayson River Ranch project is an excellent example of ways in which voluntary public participation and leadership from local agencies can make the vision for a Tuolumne River floodway come to life. Located between river mile 5 and 6 from the mouth of the Tuolumne River, the 140 acre Grayson River Ranch parcel was historically a river floodplain vegetated with riparian hardwood species. The property was cleared for cultivation as early as 1937, and has flooded repeatedly over the years.

Responding to the 1997 flood, the property owners applied for and may receive a "Perpetual Conservation Easement" for parts of the Grayson River Ranch parcel. The USDA Natural Resource Conservation Service administers easement agreements in cooperation with the East Stanislaus County Resource Conservation District, linking with various local, state, federal, and private funding sources for cost-sharing arrangements. The easement would allow for seasonal flooding and restoration of riparian habitats, while keeping the property in the hands of private owners. If the easement agreement is finalized, the NRCS will develop plans for restoring the parcel to more natural conditions, which may include re-vegetating with native riparian hardwood species or creating off-channel wetlands. With the easement completed, restoration and time, this land will provide increased fishery, wildlife, and flood management benefits.



Even with levees, many parcels of land near the confluence with the San Joaquin River are frequently flooded. These former floodplains contain soils of marginal quality for agricultural production, and generally support feed crops for livestock. However, they are ideally suited to sustain native hardwood forests as well as a lush understory of flood-dependent plant species.

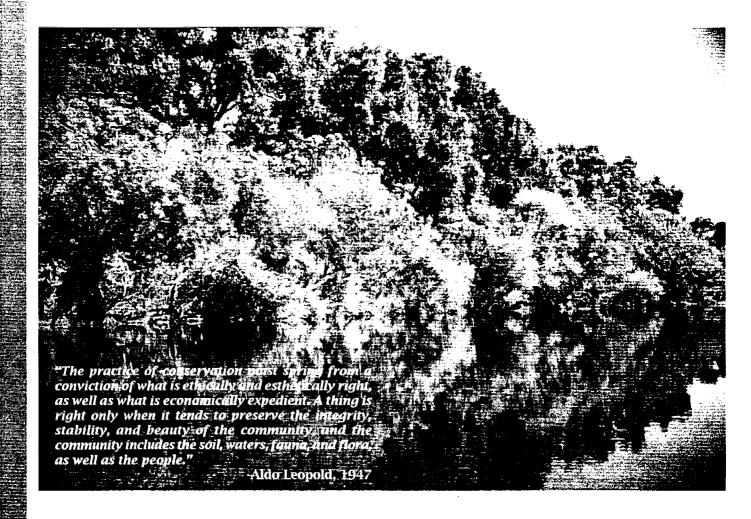
The majestic Valley Oak, once a symbol of the native California landscape and a dominant figure in riparian forests, is now nearly gone. Confined to less than 2 percent of its original habitat statewide, this flood-dependent native is endemic- it grows nowhere else but in California. Land acquisition (i.e., conservation easements) may be the only way to preserve the rare remaining groves of valley oak and allow new trees to propagate.



A few large stands of riparian vegetation persist along the Tuolumne. Although it took only decades to clear much of the land, centuries old valley oaks are not as quickly replaced. This multi-story, diverse canopy architecture provides habitat for many species of birds and wildlife.



Before the land along the Tuolumne had been converted to agriculture, old-growth oak forests extended across the floodplain to merge with the forests along the Stanislaus, Merced and San Joaquin Rivers.



THIS DOCUMENT IS A SUMMARY OF THE

Habitat Restoration Plan for the Lower Tuolumne River Corridor

PREPARED FOR

The Tuolumne River Technical Advisory Committe

WITH ASSISTANCE FROM

US Fish and Wildlife Service Anadromous Fish Restoration Program

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